Effect of Crude Oil TBP Curve Discretization on the Design and Operation of Refineries

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Crude oil contains thousands of chemical species ranging from light hydrocarbons such as methane to chemicals whose boiling points exceed 1500 ºF. This will render the application of conventional thermodynamic calculation methods to crude oil, required for the design and operation of units, a tedious and time consuming task. For this reason, many attempts have been made to lump these components into groups which exhibit similar VLE characteristics while maintaining the overall mass balance of the mixture. The lumping schemes commonly used by process simulators stem from the practical computer limitations of the late sixties and early seventies which had limited the simulators to handle a maximum of 50 components. The primary form of information available for crude oils was and continues to be, a light end analyses up to C6, an API and a volume versus boiling point curve (D86, TBP, D1160, etc.). Once the gases such as H_2S and CO_2, water and the light hydrocarbons were accounted for, about 10 of the allocated components slots were consumed, leaving about 40 components slots to model the remainder of the oil. This limitation, the requirement for higher accuracy in the lower part of the barrel and the fact that the boiling point of C6 approaches 100 ºF, led to the practice of defining pseudo-components in the crude oil by splitting the true boiling point curve into three regions, 100 to 800 ºF , 800 to 1200 ºF and 1200 ºF and higher divided respectively into 28, 8 and 3 or 4 components occupying the remaining 40 components slots. Although the 50 component limitation has long since been removed, the practice of this method of discretization has remained common, limiting the simulations to conditions in which this lumping strategy is valid. For instance, this discretization strategy cannot be used to model a naphtha splitter as the 25 ºF division range in the first region is wider than the typical operating condition of the naphtha splitter. In this study we have examined the impact of alternative discretization schemes on the design and calculated operation results of single (Crude/Vacuum Units) and multiple connect refinery units. The obtained results have been examined from a design perspective, product quality and quantity and the operating economics.